Current TES Capabilities in TRNSYS
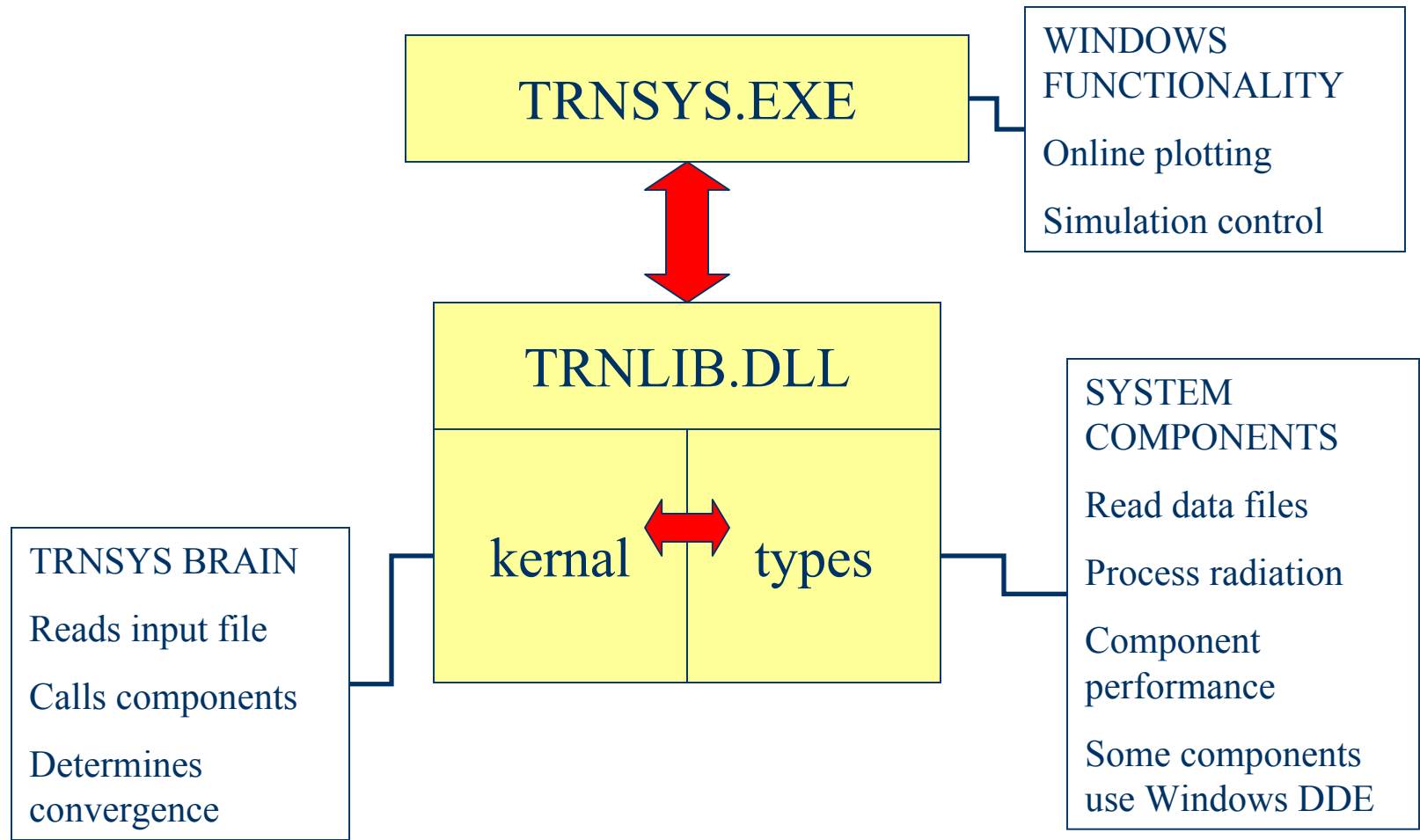
Nate Blair

Feb. 20-21, 2003

Agenda

- Quick overview of TRNSYS
- Review of current SolarPaces models
- Potential Other Models appropriate for CSP TES
- Review of Current Project Proposal
- Discussion

What is TRNSYS?

- ◆ Algebraic and differential equation solver.

- ◆ Library of common "energy system" components.

- ◆ Routines for input of weather and time-dependent forcing functions.

- ◆ Method for adding user-written components.

- ◆ Suite of utility programs.

Solver-Library Communication

TRNSYS.EXE

WINDOWS FUNCTIONALITY

Online plotting

Simulation control

TRNLIB.DLL

kernal   types

TRNSYS BRAIN

Reads input file

Calls components

Determines convergence

SYSTEM COMPONENTS

Read data files

Process radiation

Component performance

Some components use Windows DDE

TRNSYS Concepts

◆ Modular approach
  ▪ Large problem = Σ several smaller problems

◆ General formulation

◆ Entire problem reduced to :
  ▪ Formulating mathematical models.
 ▪ Describing interconnections.

System Definition

- ◆ System = set of components
    - ▪ Each component represents a process

- ◆ Components are connected to accomplish a specified task

- ◆ Simulate system performance by simulating the performance of the individual components.
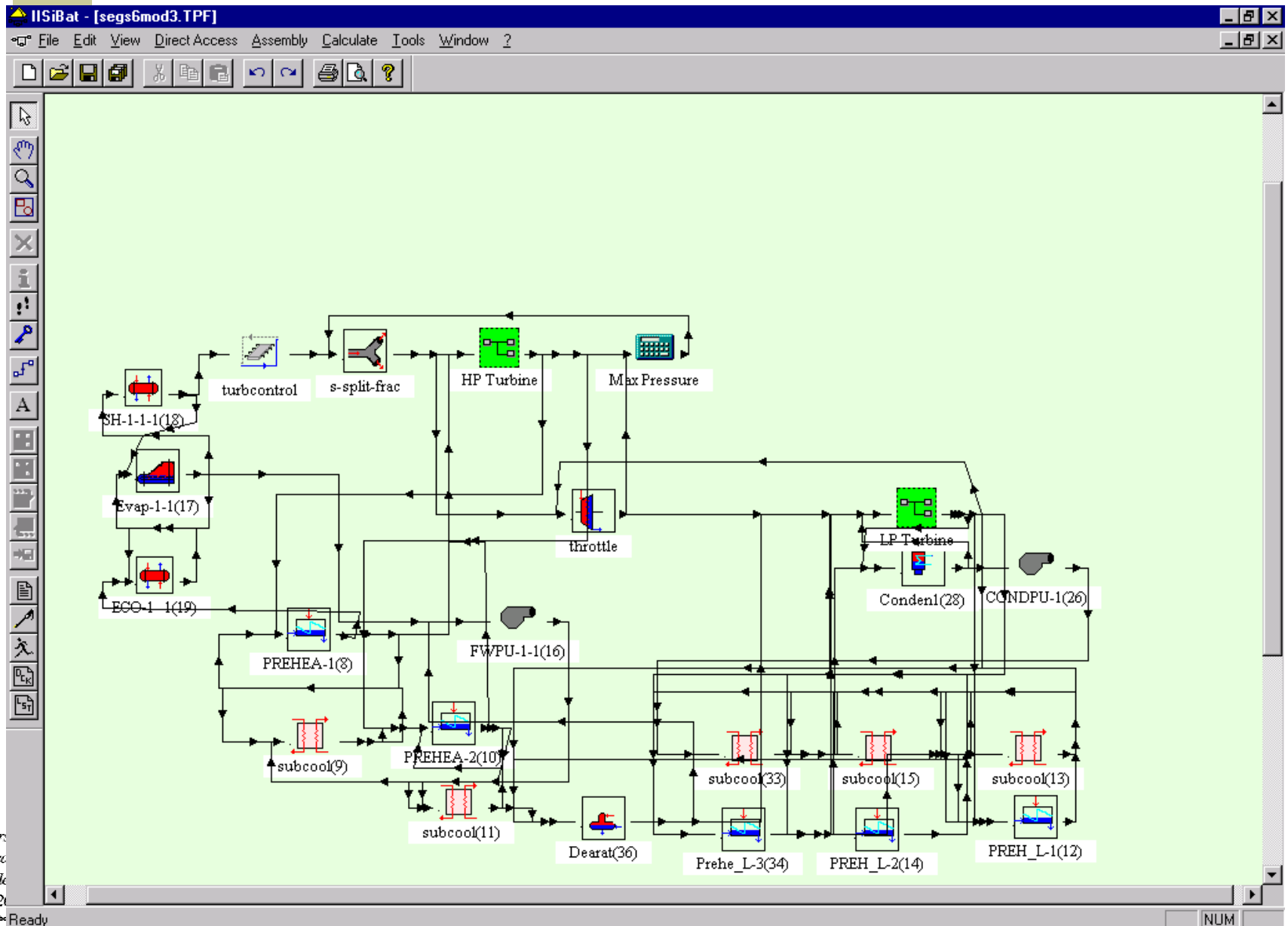
Components

- ◆ Fortran subroutines

- ◆ Generic formulation

- ◆ Choose them from a "black box" library

- ◆ Write them yourself
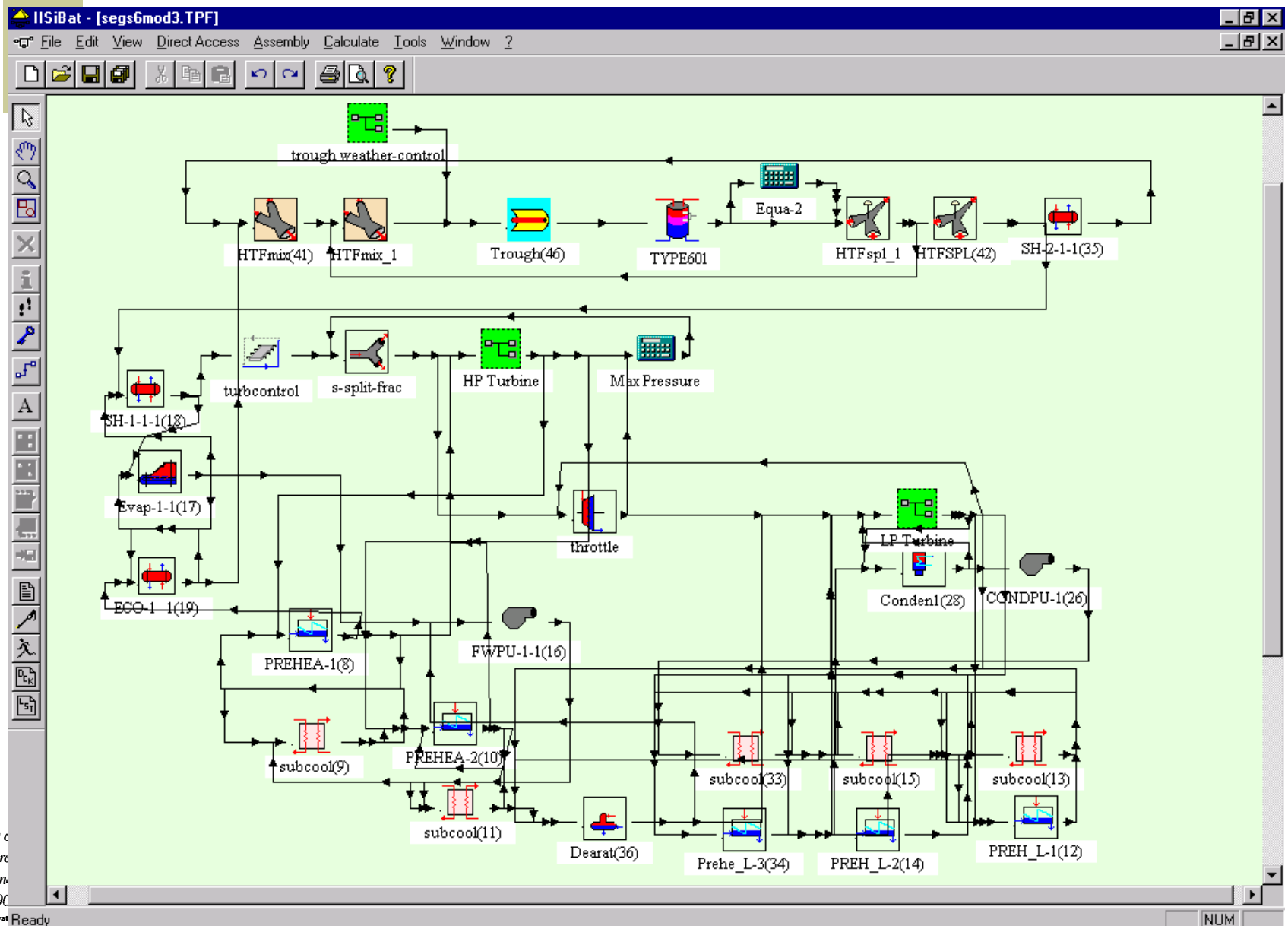
Solar-Side of SEGS 6 System Drawing in IISiBat
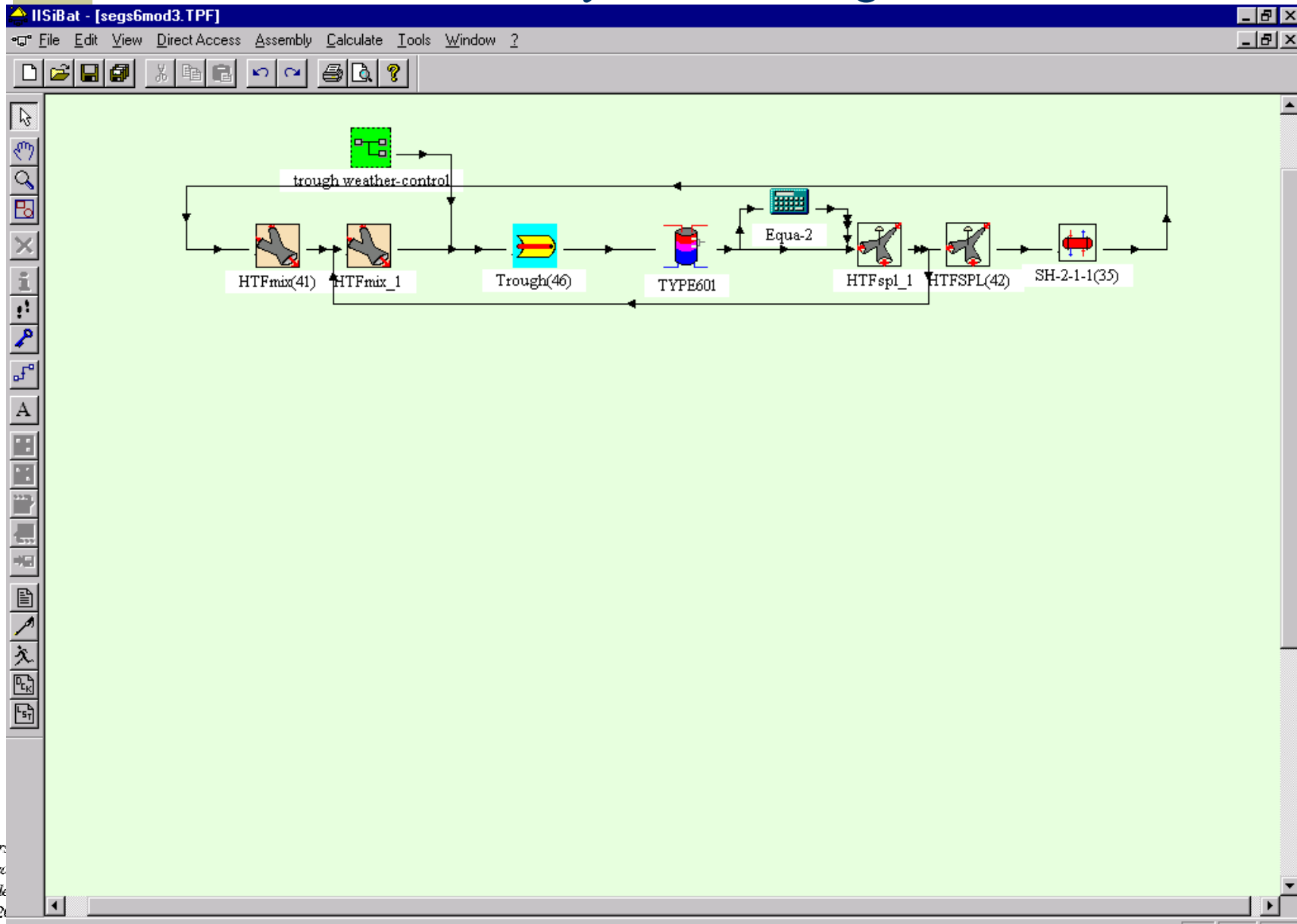
Steam Turbine-Side of SEGS 6 System Drawing in IISiBat

Combined Solar And Steam Systems in IISiBat
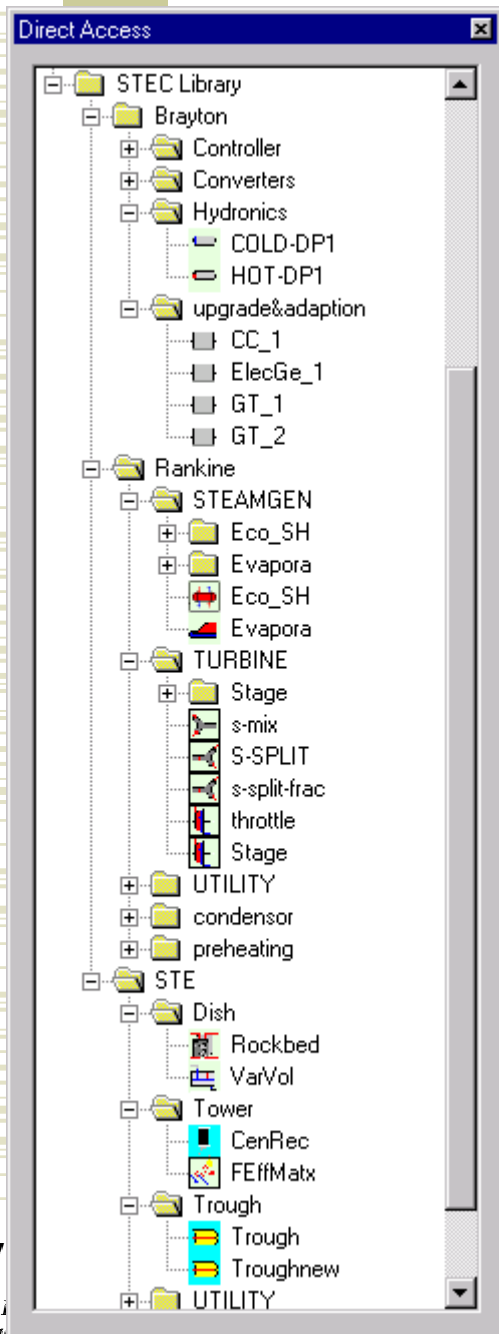
Available Components

- ◆ Three General Types of Components
  - ■ Utility Components
    - ● ex: data readers, printers, plotters

  - ■ Equipment Components
    - ● ex: chillers, solar collectors, pumps, fans

  - ■ Physical Phenomena Components
    - ● ex: psychrometrics, radiation processors, steam properties

Standard Components

◆ *Thermal Storage*
- Stratified Fluid Storage Tank
- Rock Bed
- Algebraic (Plug Flow) Tank
- Variable Volume Tank
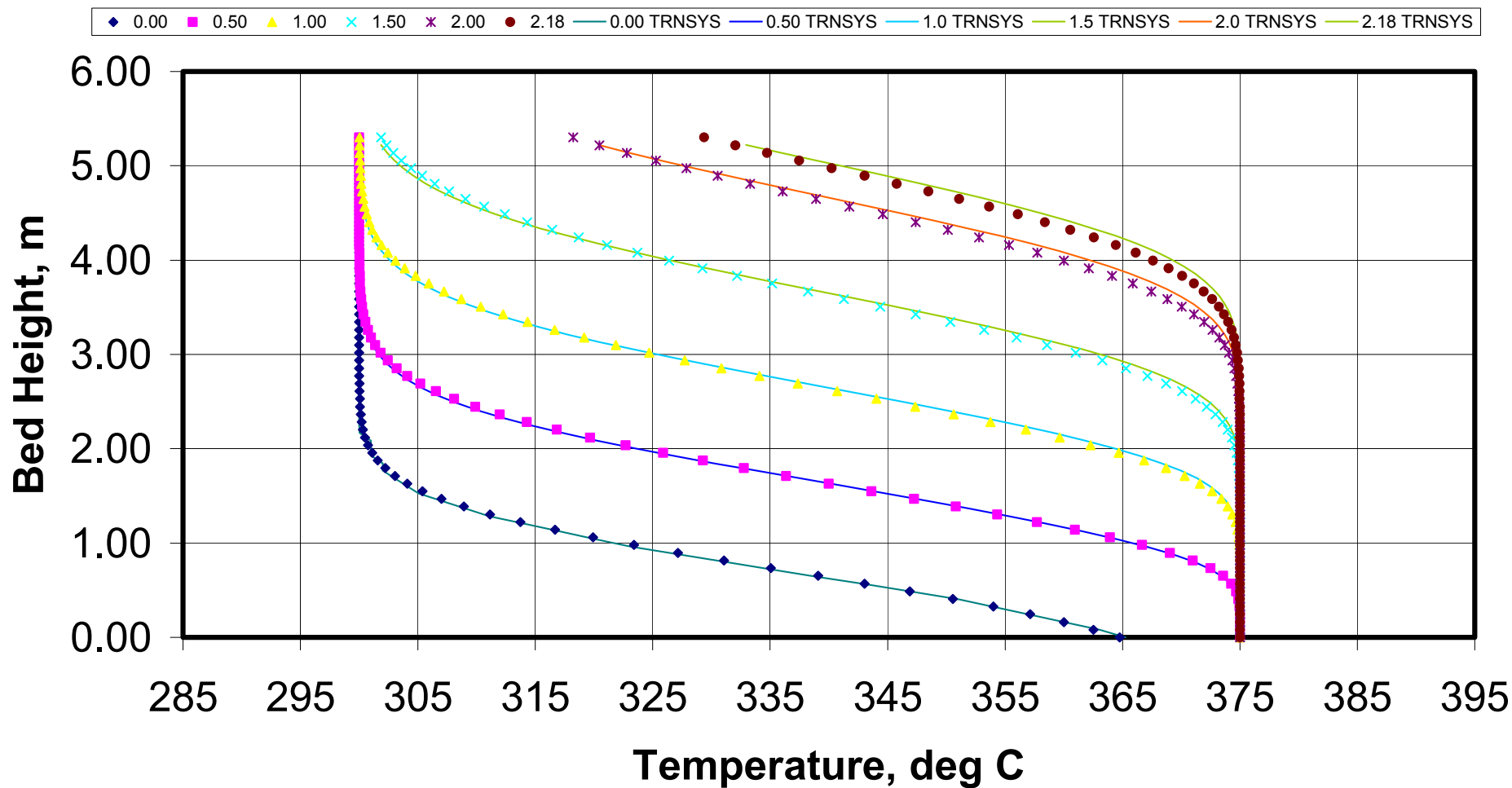- Detailed Stratified Fluid Storage Tank

STEC TRNSYS Library

Direct Access

- STEC Library
  - Brayton
    - Controller
    - Converters
    - Hydronics
      - COLD-DP1
      - HOT-DP1
    - upgrade&adaption
      - CC_1
      - ElecGe_1
      - GT_1
      - GT_2
  - Rankine
    - STEAMGEN
      - Eco_SH
      - Evapora
      - Eco_SH
      - Evapora
    - TURBINE
      - Stage
      - s-mix
      - S-SPLIT
      - s-split-frac
      - throttle
      - Stage
    - UTILITY
    - condensor
    - preheating
  - STE
    - Dish
      - Rockbed
      - VarVol
    - Tower
      - CenRec
      - FEffMatx
    - Trough
      - Trough
      - Troughnew
    - UTILITY

- Large Number of Components
- Reusable
- Able to configure different Systems
  with same components
- Created by DNR and Sandia
- Upgraded to new release of IISIBat 3
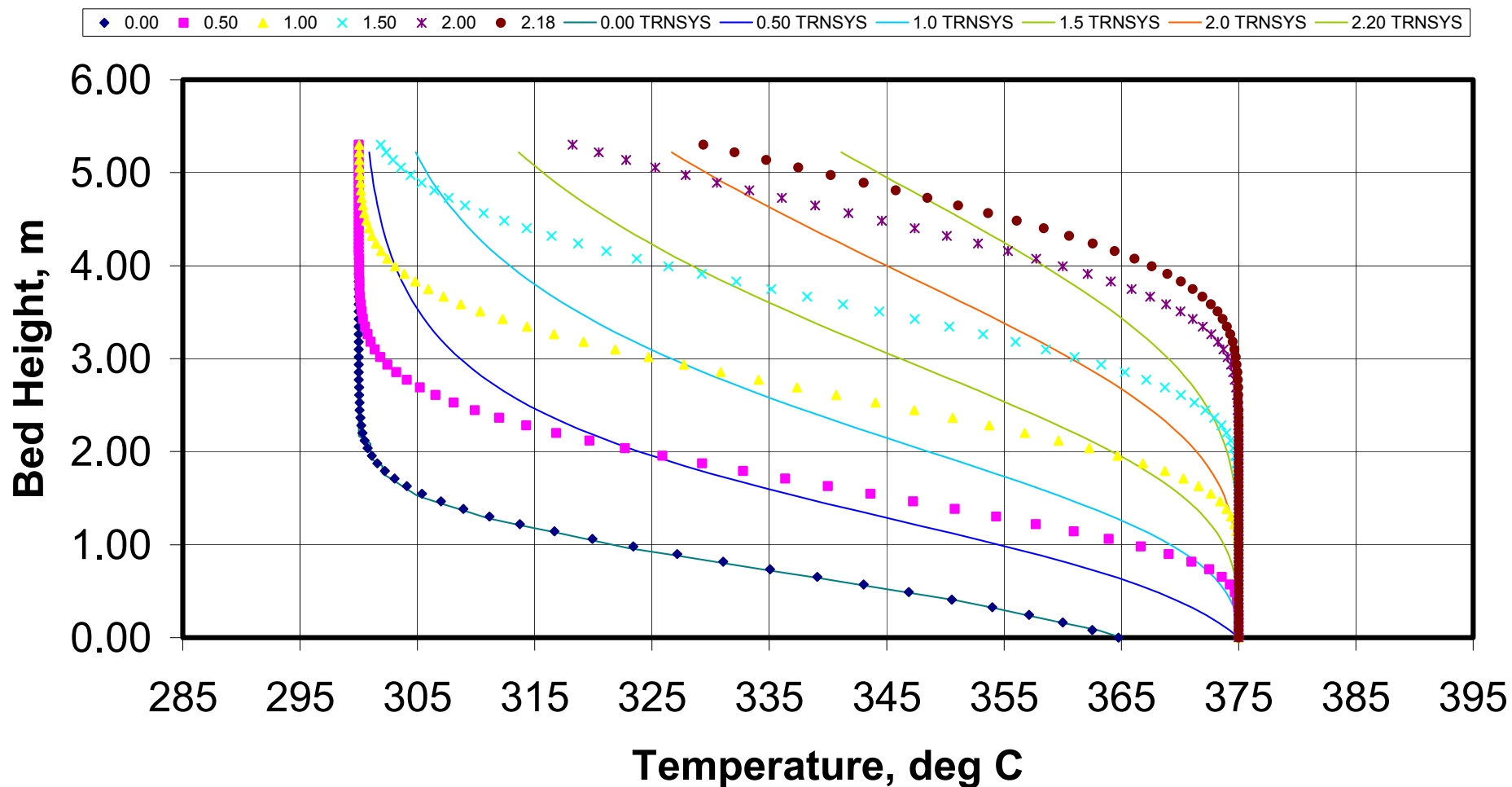(the interface) and TRNSYS 15

Thermocline Storage Modeling

- Existing Excel model for this thermocline storage at Sandia by Jim Pacheco
- In Summer 2000:
  - I compared Excel results with standard TRNSYS rockbed model (Type 10).
  - Converted the Excel model to FORTRAN as a TRNSYS component.
  - Compared both components with Pacheco's Excel model

Thermocline Profiles cond=0,loss=0,66 nodes,dt=0.001

Legend: ◆ 0.00 ■ 0.50 ▲ 1.00 ✕ 1.50 ✳ 2.00 ● 2.18 — 0.00 TRNSYS — 0.50 TRNSYS — 1.0 TRNSYS — 1.5 TRNSYS — 2.0 TRNSYS — 2.18 TRNSYS

X-axis: Temperature, deg C

Y-axis: Bed Height, m

Thermocline Profiles cond=0,loss=0,66 nodes,dt=0.5

Legend: ◆ 0.00 ■ 0.50 ▲ 1.00 ✕ 1.50 ✻ 2.00 ● 2.18 — 0.00 TRNSYS — 0.50 TRNSYS — 1.0 TRNSYS — 1.5 TRNSYS — 2.0 TRNSYS — 2.20 TRNSYS

Y-axis: Bed Height, m
X-axis: Temperature, deg C

Other Potential Storage Models

- TESS Geothermal Heat Pump Component Library:
  - Buried Horizontal Pipes (Simple and Detailed)
  - U-Tube Vertical Ground Heat Exchangers
  - Tube-in-Tube Vertical Ground Heat Exchangers
- TESS Storage Tank Component Library:
  - Vertical Cylindrical Tank
  - Horizontal Cylindrical Tank
  - Spherical Tank
  - Rectangular Tank

Other Potential Storage Models

◆ Transsolar Models (Stuttgart):

   ◆ Seasonal Ground Heat Storage (Multiport Pit Storage Model) (L. Mazarella)

   ◆ Multiport Tank Storage Model (H. Drück)

   ◆ ICEPIT Pit Storage Model for Heat and Cold Storage (M. Hornberger)

Other Potential Storage Models

- ## Various PCM TRNSYS Models
  - Other very large scale (acquifer size) models

  - Continuing to do a literature search for existing, appropriate models

Discussion